ered inefficient, low voltages (and thus low cathode potentials) eliminates or at least reduces the cell decay which occurs during normal operation at high cathode potentials.

TABLE 4

Day	Cell Voltage @ Max Current Density During Excursion (volts)	Cathode Potential @ Max Current Density (volts)	Max Current Density During Excursion (ASF)	Cell Voltage @ 250 ASF Before Excursion (volts)	Cell Voltage @ 250 ASF After Excursion (volts)
1	0.551	0.615	800	0.724	0.745
2	0.592	0.656	800	0.739	0.760
3	0.613	0.677	800	0.749	0.764
4	0.615	0.679	800	0.750	0.768
5	0.683	0.723	500	0.744	0.748
6	0.672	0.712	500	0.736	0.746
7	0.666	0.705	500	0.731	0.743
8	0.668	0.708	500	0.733	0.742

Another method for reducing the cathode potential and recovering performance, without taking the cell off-line (i.e. without effectively shutting down the cell), is to periodically and briefly operate the cell at high oxidant utilization. Oxygen utilization is the percentage of a unit volume of oxygen entering a cell that is actually used by the cell as it passes therethrough. For example, air entering the cell is about 20% oxygen and 80% nitrogen (by volume). If half of the oxygen in the air is used during a pass through the cell, the oxidant utilization is 50%. The oxygen concentration in the depleted air will have decreased from 20% at the cathode oxidant inlet to 10% at the cathode oxidant outlet. As the average oxygen concentration over the cathode decreases, the cell voltage and the cathode potential decrease. Oxidant utilization can be easily increased by reducing the oxidant flow rate.

In a demonstration, using a 20-cell stack similar to those described in the foregoing examples, the stack was operated at a steady 1000 ASF using hydrogen at the anode and air at the cathode. Under normal operating conditions the hydrogen utilization is maintained at 80% and the oxygen utilization maintained at 40%. After a period of normal operation the oxygen utilization was increased to 70% for a brief period of time every ten minutes over the course of eight hours. Each brief oxygen utilization excursion from 40% to 70% and back to 40% took no more than about seconds, with the oxygen utilization staying at the 70% level for only a second or two. This procedure essentially produced a utilization 'spike' every ten minutes.

Immediately prior to each utilization spike the cell was operating at about 0.66 volt (equivalent to a cathode potential of about 0.74 volt). As the oxygen utilization spiked upwardly, the cell voltage spiked in the opposite direction, dropping quickly to about 0.60 volt (equivalent to a cathode potential of about 0.68 volt) at 70% utilization; but it just as quickly rebounded to about 0.67 volt as the utilization returned to 40%. Over the course of the next approximately 9.5 minutes before the next spike, the cell voltage gradually fell back from 0.67 to the aforementioned 0.66 volt. Thus, by using this procedure the average cell performance level did not deteriorate from cycle to cycle.

Although the invention has been described and illustrated with respect to the exemplary embodiments thereof, it should be understood by those skilled in the art that the foregoing and various other changes, omissions and additions may be made without departing from the spirit and scope of the invention.

What is claimed is:

1. A method of operating a fuel cell having a PEM as the electrolyte, an anode on one side of the PEM, a cathode on the other side of the PEM; an external electric circuit connecting the anode and cathode, and a primary electricity using device within the external circuit, comprising the steps of

A. providing a hydrogen containing fuel to the anode and an oxygen containing oxidant to the cathode to generate, for a first period of time, an electric current within the external circuit for operating the primary electricity using device, the cell operating conditions being selected such that, during the course of said first period of time, the cathode potential is maintained above 0.66 volt and cell performance decreases;

B. regenerating the cell after Step A by a) providing a hydrogen containing fuel to the anode while operating said cell using procedures selected to reduce the cathode potential to below 0.50 volt, said procedures including the steps of i) stopping the flow of oxidant to the cell, ii) disconnecting the primary electricity using device and replacing it with a battery in the external circuit, and iii) providing a flow of hydrogen containing gas to the cathode, and b) maintaining the cathode potential below the said 0.50 volt for a second period of time sufficient to essentially the cell performance decrease which occurred during the course of Step A; and,

C. sequentially repeating Steps A and B to reduce the decrease in cell performance over time.

2. The method according to claim 1, wherein in Step B the cathode potential is maintained at 0.1 volt or less for said second period of time.

3. The method according to claim 2, wherein the said operating procedures in Step B which are selected to reduce the cathode potential includes increasing the current for said second period of time.

4. The method according to claim 1, wherein the said operating procedures of Step B which are selected to reduce the cathode potential include the steps of disconnecting the primary electricity using device from the external circuit and connecting an auxiliary resistive load in its place, stopping the flow of oxidant to the cell and allowing the oxidant remaining within the cell to be consumed at the cathode creating a current flow through the auxiliary resistive load within the external circuit, wherein each of Step B restores essentially the entire of the cell performance decrease which occurred during the immediately preceding step A.

5. The method according to claim 4, wherein in Step B said cell operating procedures are selected to reduce the cathode potential to 0.1 volt or less for said second period of time.

6. The method according to claim 1, wherein the said operating procedures in Step B which are selected to reduce the cathode potential includes increasing the oxidant utilization to at least 70% for said second period of time.

7. The method according to claim 1, wherein the said operating procedures in Step B which are selected to reduce the cathode potential includes increasing the current for said second period of time.

8. A method of operating a fuel cell having a PEM as the electrolyte, an anode on one side of the PEM, a cathode on the other side of the PEM, an external electric circuit connecting the anode and cathode, and a primary electricity using device within the external circuit, comprising the steps of

A. providing a hydrogen containing fuel to the anode and an oxygen containing oxidant to the cathode to

generate, for a first period of time, an electric current within the external circuit for operating the primary electricity using device, the cell operating conditions being selected such that, during the course of said first period of time, the cathode potential is maintained above 0.66 volt and cell performance decreases;

B. regenerating the cell after Step A by a) providing a hydrogen containing fuel to the anode while operating said cell using procedures selected to reduce the cathode potential to below 0.50 volt, said procedures including the steps of i) stopping the flow of oxidant to the cell and replacing it with a flow of inert gas, and ii) disconnecting the electricity using device from the circuit and leaving the circuit open until the cathode potential falls to below 0.5 volt, and b) maintaining the cathode potential below the said 0.50 volt for a second period of time sufficient to essentially restore the cell performance decrease which occurred during the course of Step A; and,

C. sequentially repeating Steps A and B to reduce the decrease in cell performance over time.

9. The method according to claim 8, wherein in Step B the cathode potential is maintained at 0.1 volt or less for said second period of time.

* * * * *